Growth and Welfare Effects of Macroprudential Regulation

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Abstract

This paper studies the growth and welfare effects of macroprudential regulation in an overlapping generations model of endogenous growth with banking and agency costs. Indivisible investment projects combine with informational imperfections to create a double moral hazard problem à la Holmström-Tirole and a role for bank monitoring. When the optimal monitoring intensity is endogenously determined, an increase in the reserve requirement rate (a tax on financial intermediation) has ambiguous effects on investment, growth and welfare. The trade-off between ensuring financial stability and promoting economic growth can be internalized by choosing optimally the reserve requirement rate. However, the risk of disintermediation means that financial supervision may also need to be strengthened..

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1 Introduction

The growth effects of financial volatility, and ways to mitigate them, have been largely absent from recent discussions about the implications of the global financial crisis for financial reform. Indeed, much of the recent debate has focused almost exclusively on the implications of financial volatility for *short-term* economic stability and on the short-run benefits of financial regulation—especially macroprudential policies, which take a systemic approach in addressing financial vulnerabilities—in terms of mitigating procyclicality of the financial system and dampening short-run fluctuations in credit and output.

However, understanding the longer run effects of financial regulation is essential because of the potential dynamic trade-off associated with the fact that regulatory policies, designed to reduce procyclicality and the risk of financial crises, could well be detrimental to economic growth, due to their effect on risk taking and incentives to borrow and lend—despite contributing to a more stable environment in which agents can assess risks and returns associated with their investment decisions.

In low-income countries, where sustaining high growth rates is essential to increase standards of living and escape poverty, understanding the terms of this trade-off is particularly important. These countries are often characterized by an underdeveloped formal financial system, and thus limited opportunities to borrow and smooth shocks. The real effects of financial volatility on firms and individuals can therefore be not only large but also highly persistent, thereby translating into adverse effects on growth.[1] In such conditions,

[1] These adverse growth effects are consistent with the evidence showing that financial liberalization (to the extent that it is accompanied by greater financial volatility) may not contribute much to promoting growth; see for instance Misati and Nyamongo (2012) and the overview by Fowowe (2013). The latter study, in particular, highlights the need to

the benefits of regulatory measures aimed at promoting financial stability could be fairly substantial. Yet, if regulatory constraints have a persistent effect on the risk-taking incentives of financial intermediaries—because, for instance, they induce structural shifts in banks' portfolio composition, in the form of a move away from risky assets toward safe investments—or more generally if they constrain their capacity to lend, they may translate into high interest rate spreads, suboptimal levels of borrowing by entrepreneurs to finance investment, and shifts of activity to less-regulated financial intermediaries, which could affect negatively growth and welfare. A key question therefore is to determine the *optimal* degree of financial regulation that internalizes this trade-off. Moreover, because the institutional environment in low-income countries is often weak, a related issue is what *type* of financial regulatory instruments should be implemented.

The literature on these issues, however, remains scant. One of the first analytical contributions in this area is Van den Heuvel (2008), who studied the welfare effects of bank capital requirements in a standard growth setting.[2] In line with the foregoing discussion, he argues that in a growth context capital adequacy requirements may have conflicting effects on welfare. On the one hand, by inducing banks to hold less risky portfolios, they mitigate the probability of a financial crisis, which enhances welfare.[3] On the other, by inducing a shift in banks' portfolios away from risky, but more productive, in-

strengthen prudential regulation to enhance the benefits of financial liberalisation. However, the potential adverse effects of prudential regulation itself are not discussed.

[2]A recent contribution by Barnea et al. (2015) also focuses on capital requirements. However, their focus is on the interactions between monetary policy and macroprudential regulation, rather than growth.

[3]Note that, as argued for instance by Dewatripont and Tirole (2012), equity capital may be equally effective in reducing incentives for excessive risk taking.Thus, capital requirements and portfolio restrictions may end up having the same effect of inducing banks to hold less risky portfolios.

vestment projects, toward safer, but less productive, projects, it may hamper economic growth and have an adverse effect on welfare. Capital requirements entail therefore a trade-off between banking efficiency and financial safety; as capital levels rise, there are costs, in terms of increased lending spreads or reduced loan volumes. However, a crucial limitation of the paper is that, because growth is exogenous, the implications of this trade-off for long-run growth cannot be fully explored.

This paper contributes to the literature on the growth and welfare effects of macroprudential regulation in several important ways. It uses an overlapping generations (OLG) endogenous growth model where financial intermediation is carried out only by banks. In contrast to existing studies, it focuses on reserve requirements—a prudential instrument that has been used extensively in both low- and middle-income developing countries (often as a substitute to monetary policy, as discussed by Agénor and Pereira da Silva (2015)) and has recently been made part of the liquidity requirement guidelines under the new Basel arrangement (see Basel Committee on Banking Supervision (2013)). In the model, the production of capital is subject to a dual moral hazard problem in the sense of Holmström and Tirole (1997): first, entrepreneurs, who need external funds to finance their investment projects, may be tempted to choose less productive projects with higher non-verifiable returns. Second, although bank monitoring mitigates the moral hazard problem associated with the behavior of entrepreneurs, the fact that banks use deposits from households to fund their loans creates an incentive to shirk when monitoring is costly. However, the model presented here departs from the Holmström-Tirole paradigm in two important ways. First, households cannot lend directly to producers; there is therefore only intermediated finance through banks. This assumption is more appropriate for a low-income environment, where capital markets are underdeveloped—if not entirely absent. Second, the intensity of monitoring, which affects private returns from shirking, is endogenously determined. This last feature tuns out to be crucial for the results.

The key insights from the analysis are as follows. When the monitoring costs that financial intermediaries face are exogenous, an increase in the reserve requirement rate (fundamentally a tax on financial intermediation) has unambiguously negative effects on investment and economic growth. Making banks safer by requiring them to put away a fraction of the deposits that they receive reduces the supply of loanable funds. However, when optimal monitoring intensity is endogenously determined, an increase in the reserve requirement rate has ambiguous effects on investment, growth and welfare. The trade-off between ensuring financial stability and promoting economic growth can be internalized by choosing optimally the reserve requirement rate. Nevertheless, if reserve requirements are (optimally) set at prohibitive levels, they may foster disintermediation away from the banking sector and toward less-regulated channels, which in turn may distort markets, weaken financial stability, and reduce investment and growth. The risk of disintermediation means therefore that financial supervision may also need to be strengthened when a more aggressive macroprudential policy is being implemented.

The remainder of the paper is organized as follows. Section 2 describes the model, taking the intensity of monitoring as well as the reserve requirement rate as given. The model dwells in part on Chen (2001) and Chakraborty and Ray (2006, 2007), who themselves build on the Holmström-Tirole model highlighted earlier.[4] The optimal financial contract is characterized in Section

[4] Chen's analysis focuses on the short term dynamics of asset prices and banking.

3. The equilibrium level of investment is determined in Section 4, whereas the balanced growth equilibrium path is characterized in Section 5. Autonomous changes in the monitoring intensity and the reserve requirement rate are studied in Section 6. In Section 7, optimal monitoring is analyzed and the welfare implications of a change in the reserve requirement rate in that setting are studied numerically. The last section provides some concluding remarks and discusses perspectives for further research.

2 The Model

The economy consists of a continuum of agents who live for two periods, adulthood and old age. These agents are of two types: an exogenous fraction $n \in (0, 1)$ are *workers*, the remaining are *entrepreneurs*. Without loss of generality, n is normalized to 0.5 and the measure of each type to one. Population is constant. There are three production sectors, all of them producing perishable goods, and a bank-dominated financial sector, which channels funds from savers to borrowers. There is also a financial regulator.

2.1 Workers and Entrepreneurs

A worker (or saver) is born with one unit of labor time in adulthood, which it supplies inelastically to the labor market. A generation-t worker's lifetime utility depends only upon second period consumption so that the entire wage income, w_t, is saved in adulthood. Workers do not lend directly to producers; they invest all their savings (or first-period income) either in bank deposits, d_t, or abroad. Arbitrage implies that both investments yield the same (gross)

Chakraborty and Ray (2006, 2007) do conduct their analysis in a growth context but they focus on a different issue, namely, the evolution of market-based and bank-based financial systems. They also do not consider optimal policies.

return, $R^D > 1$, which is set exogenously.

Entrepreneurs are risk neutral and indexed by $j \in [0, 1]$. Each of them is also born with one unit of labor time in adulthood, which is used to operate one of two types of technologies: a *modern technology*, which can be used to convert units of the final good into a marketable capital good; or a *traditional technology*, which can be used to produce only nonmarketed consumption goods. Whatever the technology chosen, operating it generates no income in the first period. Entrepreneurs therefore do not consume in that period either. They are altruists and derive utility from their old-age consumption, c^E_{t+1}, and bequests made to their offspring, b_{t+1}. Specifically, a typical generation-t entrepreneur's preferences are given by the 'warm-glow' utility function:

$$U^E_t = (c^E_{t+1})^\beta (b_{t+1})^{1-\beta}, \tag{1}$$

where $\beta \in (0, 1)$.[5]

An entrepreneur j's initial wealth at date t (the bequest obtained from generation $t-1$) is denoted b^j_t. Wealth is distributed among generation-t entrepreneurs according to the cumulative distribution function $G_t(b)$, which indicates the proportion of them with wealth less than b.[6]

Let z^j_{t+1} denote entrepreneur j's realized income in old age, which is derived later. Given Cobb-Douglas preferences in (1), optimal decision rules are linear in z^j_{t+1}. Thus, entrepreneur j leaves to his offspring a constant proportion of his realized income in old age:

$$b^j_{t+1} = (1-\beta) z^j_{t+1}, \tag{2}$$

the remaining fraction being consumed, so that $c^{E,j}_{t+1} = \beta z^j_{t+1}$. Equation (2)

[5] Altruism among workers can be readily incorporated in the model without qualitatively altering any of the basic results.

[6] The initial distribution G_0 is assumed to be continuous and differentiable.

tracks the wealth distribution through time, given G_0 and $\{z^j_{t+1}\}_{t=0}^{\infty}$.

2.2 Production Sectors

The production sectors in the economy consist of a *final goods sector*, which produces a unique consumption good, a *home good sector*, which produces (using the traditional technology) the same consumption good but for own use only, and a *capital goods sector*, which supplies (using the modern technology) inputs to firms producing final goods.

2.2.1 Final Goods Sector

Competitive firms produce the final good (which can be either consumed or used as a production input) by combining raw labor and capital goods. The underlying private technology exhibits constant returns in capital and labor inputs:

$$Y_t = A_t N_t^{1-\alpha} K_t^{\alpha}, \tag{3}$$

where $\alpha \in (0,1)$, N_t is the number of workers, $K_t = \int_{j \in E_t} K_t^j dG$ is the aggregate capital stock, with E_t denoting the set of entrepreneurs who supply capital goods at date t, and A_t a productivity parameter.

There is an Arrow-Romer type externality associated with the capital-labor ratio $k_t = K_t/N_t$, so that

$$A_t = A k_t^{1-\alpha}. \tag{4}$$

Combining (3) and (4) yields, in standard fashion, a linear relationship between (aggregate) production per worker, y_t, and capital per worker:

$$y_t = A k_t. \tag{5}$$

Final goods producers operate in competitive output and input markets so that equilibrium capital rental and wage rates, R_t^K and w_t, are determined by their marginal product:

$$R_t^K = \alpha A > 1, \qquad w_t = (1-\alpha)Ak_t. \tag{6}$$

2.2.2 Capital Goods Sector

Each capital good j is produced by a single entrepreneur j. Because generations of entrepreneurs are interconnected through a bequest motive (as noted earlier), firm j is effectively infinitely lived. At any given period in time, the adult member of entrepreneurial family j is the owner-manager of that firm, converting units of the final good into capital with a one-period lag.

Each entrepreneur invests an indivisible amount q^j, which is taken as given for the moment. When the project succeeds, it realizes a verifiable amount of capital,

$$K_{t+1}^j = q_t^j. \tag{7}$$

But as long as $q^j > b^j$, he has to raise the difference $q^j - b^j$ from banks. All entrepreneurs produce the same type of capital good and are price takers. The common return they earn from renting out their capital is $R^K > 1$, the (constant) marginal product of capital in a competitive equilibrium, given by (6). For simplicity, capital goods fully depreciate upon use.

2.2.3 Home Production

Entrepreneurs also possess a traditional technology whose output is not marketed and entirely self-consumed. This technology enables an entrepreneur j to produce, with a one period lag, the same consumption good (in quantity x_{t+1}^j) that the final goods sector produces:

$$x_{t+1}^j = a_t(b_t^j)^\delta, \tag{8}$$

where $\delta \in (0,1)$ and a_t is a productivity parameter. Thus, if entrepreneurs cannot borrow, they can invest their initial wealth to produce consumption goods, albeit with diminishing marginal returns. The process $\{a_{t+1}\}_{t=0}^{\infty}$ is a weakly increasing sequence of positive numbers with $\lim_{t\to\infty} a_t = \bar{a}$. Thus, a_t improves exogenously through time due for instance to some learning-by-doing effect. At the same time, productivity improvements are bounded from above under the (plausible) assumption that the traditional technology can be improved only up to a certain point.

The entrepreneur's choice of technology depends upon which one gives him a higher income and whether or not he is able to obtain external finance to operate the modern technology.

2.3 The Financial Sector

Financial intermediaries consist of banks, which obtain their supply of loanable funds from workers' deposits and use them to lend to entrepreneurs for the purpose of building capital. However, these deposits are subject to a reserve requirement imposed by the regulator. For ease of exposition, each bank is assumed to lend to one entrepreneur only.

Banks are endowed with a technology (specialized skills) that allows them to inspect a borrowing entrepreneur's cash flows and balance sheet, observe the owner-manager's activities, and ensure that the entrepreneur conforms to the terms agreed upon in the financial contract.[7] Monitoring, although imperfect, helps to address a standard agency problem that banks face in

[7]Households do not possess this technology, or even if they do, are too disparate to effectively use it. Thus, in standard fashion (see Diamond (1984)), banks act as delegated monitors. Note that the monitoring activities considered here differ from *ex post* monitoring in the costly state verification literature, where lenders monitor when the project outcome is realized and only when the borrower defaults on repayments. Accordingly, the cost of monitoring in that literature is more akin to a bankruptcy cost.

lending to entrepreneurs.

Specifically, as in Holmström and Tirole (1997), suppose that each entrepreneur is allowed to choose between three types of investment projects, which differ in their success probability and the nonverifiable private benefits that they bring.[8] Suppose also that the entrepreneur must raise funds amounting to $q_t^j - b_t^j > 0$ for his investment. When the project succeeds, it realizes the verifiable amount of capital given in (7). But when the project fails, it produces nothing; there is no remaining liquidation value.[9] The moral hazard problem arises from the fact that the probability of success depends on an unobserved action taken by the entrepreneur. The unobserved action can be interpreted as his choice of how to spend q_t^j. He can spend it on an *efficient* (good) project that results in success with probability $\pi^H < 1$ (and returning therefore $R^K q_t^j$), but uses up all of q_t^j. Or, he can spend it on one of two *inefficient* projects that may not succeed. One of these alternatives, a low-moral hazard project, costs $q_t^j - \upsilon_t q_t^j$, where $\upsilon_t \in (0, 1)$, leaving $\upsilon_t q_t^j$ for the entrepreneur to appropriate. The other inefficient choice, a high-moral hazard project, costs $q_t^j - V_t q_t^j$, where $V_t \in (0, 1)$, thereby leaving $V_t q_t^j$ in private benefits. Inefficient projects carry both the same probability of success, $\pi^L < \pi^H$, but it is assumed that $0 < \upsilon_t < V_t < 1$. Hence, the entrepreneur will always prefer the high-moral hazard project over the low-moral hazard one.[10] Only the efficient project is, however, economically

[8]Private benefits are nontransferable and capture the idea that the entrepreneur gets some kind of non-monetary return from some projects. A common interpretation is that they capture effort. Lower effort is clearly a benefit to the entrepreneur, but (as discussed next) it also leads to a lower probability of success.

[9]Returns in this framework are verifiable at no cost.

[10]While entrepreneurs consume in the second period of life, they invest in the first. As in Chakraborty and Ray (2006), it is assumed that 'illegally' appropriated investment resources cannot be invested on the financial market. Instead, they have to be hidden away for a period. Such storage yields zero net return but is unobservable and cannot be penalized. Hence, although investors know for sure that the entrepreneur was not diligent

viable and thus socially valuable; to ensure that's the case, the condition $\pi^H \alpha A - R^D > 0 > \pi^L \alpha A + V_t - R^D$ is imposed. Intuitively, this condition states that the expected net surplus per unit invested in a good project is positive, while that of a high-moral hazard project is negative—even after the private benefit is accounted for.

Monitoring partially resolves the agency problem and reduces the entrepreneur's opportunity cost of being diligent. By monitoring borrowers, banks eliminate the high-moral hazard project but not the low-moral hazard one (Holmström and Tirole (1997)). Thus, an entrepreneur is left with two choices under monitoring: selecting the efficient project or the low-moral hazard project. At the same time, monitoring involves a nonpecuniary cost for the bank, representing a nonverifiable amount $\gamma_t \in (0, 1)$, in terms of goods, per unit invested. Hence, bank monitoring will be an optimal arrangement only if the gains from resolving agency problems outweigh the monitoring costs.

3 Optimal Financial Contract

In this setting, there are three parties to the (one period) financial contract: the entrepreneur, the bank and workers. Whether or not an entrepreneur prefers to be diligent depends, as noted earlier, upon appropriate incentives and outside monitoring by the bank. For its part, the bank chooses either to lend the full amount needed to invest in the efficient technology (net of the borrower's initial wealth) or not at all. Because workers delegate to the bank the task of monitoring entrepreneurs, banks must ensure that the return that savers obtain is sufficiently high for them to deposit their funds. This section

when an investment project fails, they are unable to seize his stored goods.

characterizes the optimal contract when entrepreneurs behave diligently and choose only good projects.

3.1 Basic Structure

The optimal contract is such that no party (due to limited liability) earns anything when the project fails, whereas when it succeeds the gross return, R^K, is distributed so that

$$R^B_{t+1} + R^E_{t+1} + R^W_{t+1} = R^K, \tag{9}$$

where R^B_{t+1}, R^E_{t+1} and R^W_{t+1} denote the gross returns to the bank, the entrepreneur, and the savers, respectively.

Entrepreneur j invests q^j_t in the good project (using the modern technology) as long as it yields an incentive compatible return. As noted earlier, given that the banker always monitors if it lends, an entrepreneur will not choose the high-moral hazard project. The good project returns $R^E_{t+1}q^j_t$ with probability π^H, whereas the expected return to the low-moral hazard project (if it succeeds) is $\pi^L R^E_{t+1}q^j_t + \upsilon_t q^j_t$, that is, the sum of the (expected) market return plus the private return. The incentive compatibility constraint for the entrepreneur is thus $\pi^H R^E_{t+1}q^j_t \geq \pi^L R^E_{t+1}q^j_t + \upsilon_t q^j_t$, or equivalently

$$R^E_{t+1} \geq \frac{\upsilon_t}{\pi^H - \pi^L}. \tag{10}$$

Combining (9) and (10) implies that the maximum income that the bank and savers can be expected to earn, while still preserving the entrepreneur's incentives, is $\pi^H(R^K - R^E_{t+1})q^j_t$. As defined by Holmström and Tirole (1997), this expression represents the *pledgeable expected (gross) income* that the borrower can credibly commit.

The incentive compatibility constraint for the bank depends on the fact that it engages in monitoring. The monitoring cost is proportional (at the rate γ_t, as noted earlier) to the size of the project. Thus, the bank's incentive constraint for monitoring, and thus to engage in lending, requires that its expected return on a good project, net of monitoring costs, be greater than or equal to the expected return of a low-moral hazard project without monitoring, that is, $\pi^H R^B_{t+1} q^j_t - \gamma_t q^j_t \geq \pi^L R^B_{t+1} q^j_t$, or equivalently

$$R^B_{t+1} \geq \frac{\gamma_t}{\pi^H - \pi^L}. \tag{11}$$

The contract's objective is to maximize the representative entrepreneur's expected share of the return, $\pi^H R^E_{t+1} q^j_t$, subject to the incentive compatibility constraints (10) and (11), as well as the participation constraint for workers

$$\pi^H R^W_{t+1} q^j_t \geq R^D d_t, \tag{12}$$

and the bank's resource constraint,

$$l^j_t = q^j_t - b^j_t \leq (1 - \mu) d_t - \gamma_t q^j_t, \tag{13}$$

where $\mu \in (0, 1)$ is a reserve requirement rate set by the financial regulator, and non-negativity constraints $R^i_{t+1} \geq 0$, where $i = E, B, W$.[11] Equation (12) indicates that the expected return from the project for workers must be at least equal to the return on deposits, whereas equation (13) indicates that the loan cannot exceed deposits (adjusted for required reserves) net of monitoring costs.

As noted earlier, the expected (gross) income that the borrower can credibly pledge is at most $\pi^H (R^K - R^E_{t+1}) q^j_t$. If the bank earns a return equal to $R^B_{t+1} q^j_t$, the participation constraint for workers, equation (12), must also satisfy $\pi^H R^W_{t+1} q^j_t \leq \pi^H (R^K - R^E_{t+1} - R^B_{t+1}) q^j_t$, or equivalently, using (10) and

[11] Because banks behave competitively, all of them offer the same contract that would be offered by a single bank that maximizes the entrepreneur's expected profits.

(11),

$$\pi^H R_{t+1}^W q_t^j \leq \pi^H [R^K - (\frac{\upsilon_t + \gamma_t}{\pi^H - \pi^L})] q_t^j. \tag{14}$$

Combining (12) with (14) yields therefore

$$R^D d_t \leq \pi^H R_{t+1}^W q_t^j \leq \pi^H [R^K - (\frac{\upsilon_t + \gamma_t}{\pi^H - \pi^L})] q_t^j.$$

Using the bank's resource constraint (13), which holds as an equality in equilibrium, to eliminate d_t implies

$$\frac{R^D}{1-\mu}[(1+\gamma_t)q_t^j - b_t^j] \leq \pi^H [R^K - (\frac{\upsilon_t + \gamma_t}{\pi^H - \pi^L})] q_t^j,$$

which can be rewritten as

$$b_t^j \geq \tilde{b}_t^j = (1+\gamma_t)q_t^j - \frac{(1-\mu)\pi^H}{R^D}[R^K - (\frac{\upsilon_t + \gamma_t}{\pi^H - \pi^L})] q_t^j. \tag{15}$$

Thus, entrepreneurs with wealth lower than the minimum level $\tilde{b}_t^j$ cannot borrow because workers have no incentives, in the first place, to deposit the funds that banks need to lend. This yields the following proposition:

Proposition 1. *The threshold level of wealth below which an entrepreneur cannot borrow is increasing in the reserve requirement rate, μ.*

This is fairly intuitive; because higher required reserves reduce the bank's loanable funds, and thus the income generated through lending, the incentive compatible constraint for savers requires more self financing by borrowers.

Assuming that condition (15) holds, and given perfect competition, in equilibrium the entrepreneur earns just enough to choose the efficient project, and each bank is paid just enough to have an incentive to monitor. Assuming therefore that the incentive constraints (10) and (11) hold with equality, and using (9), yields

$$R_{t+1}^E = \frac{\upsilon_t}{\pi^H - \pi^L}, \tag{16}$$

$$R^B_{t+1} = \frac{\gamma_t}{\pi^H - \pi^L}, \tag{17}$$

$$R^W_{t+1} = R^K - (\frac{\upsilon_t + \gamma_t}{\pi^H - \pi^L}). \tag{18}$$

Thus, when there is a greater incentive to divert funds (υ_t is larger), or when the monitoring activity is more costly (γ_t is higher), the payment share of the entrepreneur or the bank must be larger (and that of workers correspondingly smaller), to be incentive compatible.

In equilibrium, only good projects are selected and banks make zero (expected) profits, so that $\pi^H R^L_{t+1} l^j_t = R^D d_t$, where the left-hand side represents the return to lending $l^j_t = q^j_t - b^j_t$, and R^L_{t+1} is the (gross) loan rate charged by the bank if the project succeeds.[12] Using (13) this condition yields

$$R^L_{t+1} = \frac{1+\gamma_t}{\pi^H(1-\mu)} R^D + \frac{\gamma_t}{\pi^H(1-\mu)}(\frac{b^j_t}{q^j_t - b^j_t}), \tag{19}$$

which implies that the lower the probability of success of the good project, or the higher the required reserve rate, the larger the spread between the deposit and loan rates.

Substituting (18) in (12), holding with equality, yields the value of deposits as

$$d_t = \frac{\pi^H}{R^D} \left\{ R^K - (\frac{\upsilon_t + \gamma_t}{\pi^H - \pi^L}) \right\} q_t, \tag{20}$$

with the difference in a worker's savings in adulthood, $w_t - d_t$, invested abroad at the rate R^D.

3.2 Entrepreneurial Income under Optimal Contracts

Let z^j_{t+1} denote entrepreneur j's second period income and consider first the case where his first-period initial wealth is insufficient, $b^j_t < \tilde{b}^j_t$, to obtain

[12] By definition, it must also be that $R^L_{t+1} l^j_t = R^B_{t+1} q^j_t$. Using (11), this expression yields therefore $R^L_{t+1}(q^j_t - b^j_t) = \gamma_t q^j_t/(\pi^H - \pi^L)$, or equivalently, $R^L_{t+1} = \gamma_t(\pi^H - \pi^L)^{-1} q^j_t/(q^j_t - b^j_t)$. This expression provides an alternative solution for the equilibrium gross loan rate.

external financing. He can either deposit his assets abroad (at the same rate R^D as workers) or use them in household production.[13] He will engage in the latter as long as $a_t(b_t^j)^\delta \geq R^D b_t^j$, that is, $b_t^j \leq \hat{b}_t^j = (a_t/R^D)^{1/(1-\delta)}$. This will be true under appropriate restrictions.[14] The entrepreneurs' income in that case is given by

$$z_{t+1}^j = a_t(b_t^j)^\delta. \tag{21}$$

Second, consider the case where entrepreneur j borrow from banks, so that $q_t > b_t^j \geq \tilde{b}_t^j$. From (9), $z_{t+1}^j = R^K q_t^j - R_{t+1}^B q_t^j - R_{t+1}^W q_t^j$. Using $R_{t+1}^B q_t^j = R_{t+1}^L l_t^j$ and (**??**), and the fact that from (12), holding with equality, $R_{t+1}^W q_t^j = R^D d_t/\pi^H$, this expression can be written as $z_{t+1}^j = R^K q_t^j - R_{t+1}^L(q_t^j - b_t^j) - R^D d_t/\pi^H$. Using (6), as well as (13) and (19) to eliminate R_{t+1}^L and d_t, yields therefore

$$z_{t+1}^j = [\alpha A - \frac{2R^D}{\pi^H(1-\mu)}](1+\gamma_t)q_t^j + \frac{2R^D + \gamma_t(R^D - 1)}{\pi^H(1-\mu)} b_t^j. \tag{22}$$

4 Investment Decision

Having characterized financial contracts and returns from an arbitrary investment level, we turn to the entrepreneur's investment decision, that is, the optimal choice of q_t. Recall that entrepreneurs operate either a modern or a traditional technology. Entry into modern-sector activities requires a setup cost, in the form of fixed capital requirements and costs of adapting newer types of technologies. Thus, any entrepreneur wishing to produce capital goods must invest a minimum of q_m.

[13] If $b_t^j < b_t^L \; \forall j$, banks would not be able to lend to any entrepreneur and would therefore not accept any deposits.

[14] To ensure that the entrepreneur chooses to invest in the traditional technology, instead of investing in deposits abroad, it must be assumed that $b_m < \hat{b}_0 = (a_0/R^D)^{1/(1-\delta)}$, where b_m, defined later, is the minimum level of wealth needed to qualify for bank financing when $q = q_m$.

4.1 Minimum Investment Size

The minimum investment size q_m associated with the use of the modern technology defines the minimum wealth (internal funds), b_m, required to secure external finance. From (6) and (15), this constraint is given by

$$b_m = \left\{(1+\gamma_t)R^D - (1-\mu)\pi^H[\alpha A - (\frac{\upsilon_t + \gamma_t}{\Delta\pi})]\right\}\frac{q_m}{R^D}, \qquad (23)$$

where $\Delta\pi = \pi^H - \pi^L$.

Credit-rationed entrepreneurs, with $b_t^j < b_m$, operate the traditional technology, and leave bequests according to, given (2) and (21),

$$b_{t+1}^j = (1-\beta)z_{t+1}^j = (1-\beta)a_t(b_t^j)^\delta. \qquad (24)$$

The minimum wealth level b_m and the wealth distribution determine the size of the traditional (home production) sector at any point in time. Indeed, $G_0(b_m)$ indicates the fraction of generation-0 entrepreneurs with assets less than b_m, and hence, the initial size of the traditional sector.

As noted earlier, the traditional technology is subject to exogenous productivity improvements. To rule out perpetual stagnation in the traditional sector, $\bar{a}$ must be allowed to be large enough to ensure that $b_{t+1}^j(\bar{a}) > b_m$. This means that entrepreneurial families who do not obtain external financing initially would ultimately accumulate enough wealth to enter the modern sector anyway. But how long they remain in the traditional sector depends on the efficiency of the banking system and on the process characterizing a_t.

4.2 Optimal Investment Decision

For an investment of q_t, the minimum amount of initial wealth required to qualify for bank finance is $b_0 \geq b_m$; it must also be that $b_m < q_0$, otherwise there would be no need to borrow. Given optimal contracts and financing arrangements for any investment q_t, an entrepreneur j chooses q_t to maximize his income z_{t+1}^j, as defined in (22). From (15), the maximum level of investment, for a given level of entrepreneurial wealth, is thus, using again (6),

$$\tilde{q}_t^j = \frac{R^D b_t^j}{(1+\gamma_t)R^D - (1-\mu)\pi^H[\alpha A - (\upsilon_t + \gamma_t)/\Delta\pi]}, \tag{25}$$

where, to ensure that the level of investment is positive, and that $\tilde{q}_t^j > b_t^j$, the following restrictions are imposed:

$$R^D > (1+\gamma_t)R^D - (1-\mu)\pi^H[\alpha A - (\frac{\upsilon_t + \gamma_t}{\Delta\pi})] > 0. \tag{26}$$

Using (16) and (25), the entrepreneur's optimal earning is

$$\tilde{z}_{t+1}^j = \frac{\upsilon_t R^D b_t^j/\Delta\pi}{(1+\gamma_t)R^D - (1-\mu)\pi^H[\alpha A - (\upsilon_t + \gamma_t)/\Delta\pi]}. \tag{27}$$

Thus, all entrepreneurs in the range $b_t^j > b_m$ borrow from the bank, as long as $\tilde{q}_t^j - b_t^j > 0$. Note that $b_t^j < \tilde{b}_t^j$ for any $q_t^j > \tilde{q}_t^j$. Thus, an entrepreneur wishing to invest more than $\tilde{q}_t^j$ cannot obtain funds for his project, and is rationed out of the credit market; he can only resort to household production in that case and earn an income defined in (21).

5 Balanced Growth Equilibrium

From (2) and (29), the wealth of an entrepreneur j who is not credit constrained ($b_t^j \geq b_m$) evolves according to

$$b_{t+1}^j = (1+g)b_t^j, \tag{28}$$

where the growth rate $1+g$ is defined as

$$1+g = \frac{(1-\beta)\upsilon_t R^D/\Delta\pi}{(1+\gamma_t)R^D - (1-\mu)\pi^H[\alpha A - (\upsilon_t + \gamma_t)/\Delta\pi]}, \tag{29}$$

where, to ensure that $g > 0$, the following restrictions are imposed:[15]

$$\frac{(1-\beta)\upsilon_t R^D}{\Delta\pi} > (1+\gamma_t)R^D - (1-\mu)\pi^H[\alpha A - (\frac{\upsilon_t + \gamma_t}{\Delta\pi})] > 0. \qquad (30)$$

As implied by (25), the optimal investment choice is linear in entrepreneurial wealth. The aggregate stock of capital in $t+1$ depends on all investments undertaken in t. Define

$$Q_t = \int_{b_m}^{\infty} \tilde{q}_t^j dG_t, \qquad B_t = \int_{b_m}^{\infty} b_t^j dG_t.$$

Because optimal loan contracts ensure that all entrepreneurs behave diligently, aggregate (and per capita) capital produced is, using (7),

$$k_{t+1} = Q_t = \frac{R^D B_t}{(1+\gamma_t)R^D - (1-\mu)\pi^H[\alpha A - (\upsilon_t + \gamma_t)/\Delta\pi]}. \qquad (31)$$

Using (28) yields $k_{t+1} = (1+g)k_t$, so that aggregate capital per capita grows at the same rate as entrepreneurial wealth.

From (5), because the aggregate production function is linear in capital, the growth of output mimics that of capital. Similarly, given that from (6) the equilibrium wage rate is linear in capital, and that second-period consumption of workers is equal to $R^D w_t$, worker consumption grows at the same rate as the rate of growth of the capital stock. For entrepreneurs, in equilibrium all of them access credit markets and borrow from banks. From (27), and because $c_{t+1}^E = \beta z_{t+1}^j$, their consumption is linear in wealth and hence grows at the same rate as workers' consumption and output.

6 Autonomous Policy Changes

Consider first the effect of reducing the unit monitoring cost, γ_t, perhaps through better contract enforcement, and suppose that the private benefit of

[15] Note that if $(1-\beta)\upsilon_t/\Delta\pi < 1$, conditions (30) are redundant if conditions (25) hold.

the low-moral hazard project is decreasing and convex in monitoring intensity, so that $\upsilon_t = \upsilon(\gamma_t)$, with $\upsilon' \leq 0$, $\upsilon'' \geq 0$, and $\lim_{\gamma_t \to \infty} \upsilon'(\gamma_t) = 0$. Thus, monitoring not only helps to eliminate the high-moral hazard project, it also mitigates the benefits that can be derived from (and thus the incentives to engage in) low-moral hazard projects. The following proposition can then be established:

Proposition 2. *A reduction in monitoring intensity, γ, when the private benefit of the low-moral hazard project is decreasing and convex in that variable, has ambiguous effects on investment and the steady-state growth rate.*

Equations (16), (17), and (18) help to illustrate the direct impact of this change. A reduction in γ_t raises the per-unit project return R^E_{t+1} that must be promised to entrepreneurs, because it increases their ability to divert resources ($\upsilon(\gamma_t)$ increases). At the same time, this lowers R^B_{t+1}, the per-unit share of the project's return that must be allocated to bankers in order for them to find it profitable to monitor as intensively as promised. Equation (18) shows that the per-unit share of project return that can be credibly promised to workers supplying loanable funds is thus ambiguous in general; it depends on the efficiency of the monitoring technology. From (5), (25), and (31), the effect on the optimal level of investment and output growth is also ambiguous. If υ' is relatively small, the impact on the banker's return will dominate, and R^W_{t+1} will increase. This leads to greater borrowing and higher investment by all entrepreneurs. Lower monitoring costs therefore also increase the growth rate output.

A reduction in monitoring costs also results in a *level effect*, because it increases the level of per capita output when the policy is implemented. Indeed, a lower γ reduces the minimum wealth that entrepreneurs need to enter the modern sector (see equation (23)). Because per capita output is proportional to the fraction of entrepreneurs in the modern sector, relaxing the credit constraint raises output. Financial reform, thus, encourages traditional sector entrepreneurs to enter the modern sector, improving the distribution of income among entrepreneurs and speeding up structural transformation.

Consider now an increase in the reserve requirement rate, μ.[16] The following result can be established:

Proposition 3. *An increase in the reserve requirement rate, μ, with constant monitoring intensity and $\upsilon' \geq 0$, unambiguously lowers investment and the steady-state growth rate.*

Intuitively, the policy raises the cost of borrowing (see (19)), which leads to lower optimal investment (see (25)) and a lower growth rate of output. There is also an adverse level effect, because the policy tends now to raise the minimum wealth needed to borrow and enter the modern sector (see (23)). It thus also worsens income distribution among entrepreneurs. As discussed next, however, once monitoring intensity is endogenized and $\upsilon' > 0$,, these results are no longer unambiguous.

7 Optimal Policy

In the foregoing analysis, both the intensity of monitoring and the reserve requirement rate were taken as given. In the first part of this section the intensity of monitoring is endogenized, as part of an optimization problem by the bank. In the second part the growth- and welfare-maximizing values of the reserve requirement rate, taking into account its impact on the optimal monitoring intensity, are derived.

[16] Note that the policy also plays the role of a partial deposit insurance.

7.1 Optimal Monitoring Intensity

The optimal choice of γ_t, with $\upsilon_t = \upsilon(\gamma_t)$, maximizes the entrepreneur's expected profits, $\pi^H R^E_{t+1} q^j_t$, which, using (16) and (25), can be written as

$$\pi^H R^E_{t+1} q^j_t = \frac{\pi^H \upsilon(\gamma_t) R^D b^j_t / \Delta\pi}{(1+\gamma_t)R^D - (1-\mu)\pi^H[\alpha A - (\upsilon(\gamma_t)+\gamma_t)/\Delta\pi]}. \tag{32}$$

To derive a tractable analytical solution to the problem, suppose as in Haavio et al. (2014) for instance, that $\upsilon(\gamma_t)$ takes the following functional form:

$$\upsilon(\gamma_t) = \begin{cases} \Gamma\gamma_t^{-\varepsilon/(1-\varepsilon)} & \text{if } \gamma_t > \gamma_m \\ \upsilon_m & \text{if } \gamma_t \leq \gamma_m \end{cases}, \tag{33}$$

where $\Gamma > 0$, $\upsilon_m > 0$, $\varepsilon \in (0,1)$, and $\gamma_m \geq 0$. The first row of equation (33) shows that $\upsilon(\gamma_t)$ is differentiable and strictly convex for $\gamma_t > \gamma_m$ and that the monitoring technology is the more efficient the larger is Γ or the smaller is ε. The second row implies that there is a minimum efficient scale for monitoring investments or an upper bound for the private revenues. This upper bound ensures that the net rate of return on a bad project is negative even for low levels of γ_t.

Under the minimum scale requirement, the entrepreneur may choose a corner solution with no monitoring $\gamma_t = 0$; $\upsilon(\gamma_t) = \gamma_m$, or a unique interior solution $\gamma_t = \tilde{\gamma}$. After substituting equations (33) in (32) the first-order condition for this problem is, with $\gamma_t > \gamma_m$ and taking initial wealth as given,

$$-\left\{\tilde{\gamma}R^D - \frac{(1-\mu)\pi^H}{\Delta\pi}[\frac{\varepsilon}{1-\varepsilon}\upsilon(\tilde{\gamma}) - \tilde{\gamma}]\right\}$$
$$\frac{-\varepsilon}{1-\varepsilon}\left\{(1+\tilde{\gamma})R^D - (1-\mu)\pi^H[\alpha A - (\frac{\upsilon(\tilde{\gamma})+\tilde{\gamma}}{\Delta\pi})]\right\} = 0,$$

from which it can be shown that

$$\tilde{\gamma} = \frac{\varepsilon[(1-\mu)\pi^H\alpha A - R^D]}{R^D + (1-\mu)\pi^H/\Delta\pi}. \tag{34}$$

Equation (34) yields the following proposition:

Proposition 4. *The optimal level of monitoring intensity, when the private benefit of the low-moral hazard project is decreasing and convex in that variable, is decreasing in the reserve requirement rate, μ, and increasing in the elasticity of the monitoring technology, ε.*

Intuitively, a more efficient monitoring technology magnifies the benefit of monitoring and raises the optimal intensity of monitoring; this lowers the private benefit of the low-moral hazard project. However, as implied by Proposition 2, this does not necessarily promote investment and growth. More importantly for the issue at stake, a higher reserve requirement rate reduces the optimal intensity of monitoring because it reduces the bank's income if the project succeeds. Put differently, prudential regulation distorts the incentives of banks to monitor and lend.

From equations (25), (29) and (34) it can also be established that:

Proposition 5. *An increase in the reserve requirement rate, μ, with monitoring intensity set optimally and with $v' < 0$, has ambiguous effects on investment and the steady-state growth rate.*

Thus, in contrast to the results reported in Proposition 3, when monitoring intensity is endogenous and set optimally, it is possible for an increase in the reserve requirement rate to have *positive* effects on investment and growth. Intuitively, as noted earlier, when v is endogenous a higher monitoring intensity affects incentives for the entrepreneur and the banker in opposite directions; for the entrepreneur, it tends initially to increase the optimal level of investment (as implied by (25)), whereas for the banker, it increases monitoring costs and thus the loan rate. This tends in turn to mitigate borrowing and the increase in investment, which translates into ambiguous effects on growth. As discussed next, these results are important to study the determination of the optimal reserve requirement rate.

7.2 Optimal Reserve Requirement Rate

A natural benchmark for the optimal reserve requirement rate is the solution that maximizes welfare of the present generation. To obtain that solution note first that given (1), the indirect utility function of entrepreneurs is linear in income, so that $U^E_{t+1} = \beta^\beta(1-\beta)^{1-\beta}z_{t+1}$. Given that there is no consumption in adulthood, this is also the present value of utility. Similarly, for workers, the indirect utility function is $c^W_{t+1} = R^D w_t$, given that all income (including interest) is consumed in adulthood. Because each group represents half of the population, a natural welfare criterion is a weighted average of utility, so that

$$\mathfrak{W}_t = 0.5\beta^\beta(1-\beta)^{1-\beta}z_{t+1} + 0.5R^D w_t.$$

From (6) and (27), along the balanced growth path,

$$\mathfrak{W}_t = 0.5\left\{\frac{\beta^\beta(1-\beta)^{1-\beta}\tilde{\upsilon}R^D\tilde{b}_t/\Delta\pi}{(1+\tilde{\gamma})R^D - (1-\mu)\pi^H[\alpha A - (\tilde{\upsilon}+\tilde{\gamma})/\Delta\pi]} + R^D(1-\alpha)A\tilde{k}_t\right\}.$$

From (28) and (31), b_t and k_t grow at the same rate along the balanced growth path. Along the steady-state equilibrium path, $\tilde{x}_t = (1+\tilde{g})^t x_0$, where $x = b, k$. Thus, welfare is increasing in the equilibrium growth rate and depends on time. To obtain a bounded solution consider the case where only the welfare of the current generation of old adults (setting therefore $t = 1$, given that they are born at $t = 0$) matters. Thus, ignoring the term 0.5 in the above equation, welfare can be evaluated as

$$\mathfrak{W} = \frac{\beta^\beta(1-\beta)^{1-\beta}\tilde{\upsilon}R^D b_0(1+\tilde{g})/\Delta\pi}{(1+\tilde{\gamma})R^D - (1-\mu)\pi^H[\alpha A - (\tilde{\upsilon}+\tilde{\gamma})/\Delta\pi]} + R^D(1-\alpha)Ak_0(1+\tilde{g}), \tag{35}$$

with $\tilde{\gamma}$, $\tilde{\upsilon}$, and $1+\tilde{g}$ obtained from the solution of (29), (33), and (34). The optimal value of μ is the one for which $d\mathfrak{W}/d\mu = 0$ is obtained. Unfortunately, the resulting expression is too complex to allow an explicit analytical solution for μ.

Accordingly, a numerical evaluation in performed. This is done by noting that equations (29), (33) with $\gamma_t > \gamma_m$, and (34) consist of a recursive, static system in $\tilde{\gamma}$, $\tilde{v}$, and $1 + \tilde{g}$. This system can be solved, subject to restrictions (26) and/or (30), for values of μ varying in the interval $(0, 1)$. The optimal value of μ is thus the one for which the highest value of $\mathfrak{W}$ in (35) is obtained. To perform the simulations, the following initial values are used: $\alpha = 0.3$, $A = 3.5$, $\beta = 0.55$, $\pi^H = 0.95$, $\pi^L = 0.05$, $\Gamma = 0.1$, and $R^D = 1.04$. Given the values of α and A, the rate of return on capital is therefore $R^K = 1.05$. Solutions are obtained by performing a grid search for μ over the interval $(0.05, 0.7)$ for ε, with a grid step of 0.05.

The results show that there is an inverse relationship between the welfare-maximizing value of μ and ε. For $\varepsilon = 0.1$ for instance, the optimal value is $\mu = 0.387$; and for $\varepsilon = 0.55$, the optimal value is $\mu = 0.125$. Intuitively, a higher elasticity of the monitoring technology magnifies the negative effect of an increase in the reserve requirement rate on reducing the unit monitoring cost. In turn, a larger reduction in γ means a larger positive effect on the private benefit of the low-moral hazard project. At the same time, as μ rises, it reduce the bank's loanable funds and increases the threshold level of wealth below which an entrepreneur cannot borrow. Both effects combine to reduce investment and growth. To maximize welfare, it is thus optimal to reduce μ as ε increases.

8 Conclusion

Using an OLG model with banking, this paper examined the growth and welfare effects of macroprudential regulation. In the model, the production of capital is subject to a dual moral hazard problem in the tradition of Holmström and Tirole (1997). Entrepreneurs act in a moral-hazard-like fashion by using some of the proceeds of their loans to pay for unproductive activities. Banks are cognizant of this type of behavior and may choose to monitor borrowers to prevent it. A monitoring bank is always successful in preventing unproductive entrepreneurial behavior. However, given it is costly to monitor, the bank has a tendency not to monitor properly unless it is provided with adequate incentives to do so. In addition, however, it was assumed that households cannot lend directly to producers and that the intensity of monitoring, which affects private returns from shirking, is endogenously determined.

The analysis focused on the impact of reserve requirements, a prudential instrument that has been used extensively in both low- and middle-income developing countries, and has recently been made part of the liquidity requirement guidelines under the new Basel arrangement. It was first shown that the direct effect on investment and economic growth of reserve requirements, which represent essentially a tax on financial intermediation, is negative when monitoring intensity is taken as given. However, the same policy has ambiguous effects on growth when monitoring intensity is endogenized because it also affects banks' incentives to monitor. Numerical experiments showed that, depending on the parameters characterizing the economy, macroprudential policy can be both growth- and welfare enhancing. Put differently, there is not necessarily a trade-off between ensuring financial stability and promoting economic growth; both concerns can be balanced by setting the reserve requirement rate at his optimal value.

An important caveat to the analysis relates to the fact that the model did not account explicitly for the possibility that even though reserve requirements are set optimally, their level may be so high that they may foster disintermediation away from the formal banking system and toward less-regulated channels. This may in turn weaken financial stability, while at the same time reducing investment and growth. The possibility of leakages means therefore that financial sector supervision may also need to be strengthened when macroprudential policy reforms are being implemented. This is an important message for policymakers.

The analysis presented here can be extended in a number of directions. First, a better integration of short-run stabilization issues and longer-term considerations would be useful. In particular, if macroprudential regulation can mitigate business cycle volatility and reduce uncertainty about future economic conditions, it may have a permanent, positive effect on private investment and economic growth. Second, the focus of the present analysis was on a single macroprudential instrument. In addition to the fact that reserve requirements have been used extensively (as noted earlier), this focus is justified by the fact that in a weak institutional environment (as is often the case in developing countries, especially the poorest ones), macroprudential rules aimed at preserving financial stability should not be overly complicated. However, it would be useful to consider other instruments in this setting, such as capital requirements and a leverage ratio, and solve *jointly* for the optimal levels of these instruments. Third, the model presented here does not capture potential gains generated by access to credit markets in terms of consumption smoothing. Finally, in the model, as in the original Holmström-

Tirole tradition, monitoring reduces entrepreneurial moral hazard (which increases pledgeable income and facilitates access to credit) but it does not affect projects' profitability. However, as discussed in Favara (2012), where monitoring affects the quality (or value) of the projects implemented, by interfering in the *ex ante* selection of projects. Integrating this mechanism would provide an additional channel through which macroprudential policy could affect growth and welfare.

References

Agénor, Pierre-Richard, and Luiz Pereira da Silva, "Reserve Requirements and Loan Loss Provisions as Countercyclical Macroprudential Instruments," unpublished, Inter-American Development Bank (November 2015).

Barnea, Emanuel, Yoram Landskroner, and Meir Sokoler, "Monetary Policy and Financial Stability in a Banking Economy: Transmission Mechanism and Policy Tradeoffs," *Journal of Financial Stability*, 18 (June 2015), 78-90.

Basel Committee on Banking Supervision, *Basel III: The Liquidity Coverage Ratio and Liquidity Risk Monitoring Tools*, Report No. 238 (January 2013).

Chakraborty, Shankha, and Tridip Ray, "Bank-Based versus Market-Based Financial Systems: A Growth-Theoretic Analysis," *Journal of Monetary Economics*, 53 (March 2006), 329-50.

——, "The Development and Structure of Financial Systems," *Journal of Economic Dynamics and Control*, 31 (September 2007) 2920-56.

Chen, Nan-Kuang, "Bank Net Worth, Asset Prices, and Economic Activity," *Journal of Monetary Economics*, 48 (October 2001), 415-36.

Dewatripont, Mathias, and Jean Tirole, "Macroeconomic Shocks and Banking Regulation," *Journal of Money, Credit and Banking*, 44 (December 2012), 237-54.

Diamond, Douglas W., "Financial Intermediation and Delegated Monitoring," *Review of Economic Studies*, 51 (July 1984), 393-414.

Favara, Giovanni, "Agency Problems and Endogenous Investment Fluctuations," *Review of Financial Studies*, 25 (July 2012), 2301-42.

Fowowe, Babajide, "Financial Liberalization in Sub-Saharan Africa: What do we Know?," *Journal of Economic Surveys*, 27 (March 2013), 1-37.

Haavio, Markus, Antti Ripatti, and Tuomas Takalo, "Macroeconomic Effects of Bank Recapitalizations," unpublished, Bank of Finland (February 2014)

Holmström, Bengt, and Jean Tirole, "Financial Intermediation, Loanable Funds, and the Real Sector," *Quarterly Journal of Economics*, 112 (September 1997), 663-91.

Lin, Pei-Chien, Ho-Chuan Huang, "Banking Industry Volatility and Growth," *Journal of Macroeconomics*, 34 (December 2012), 1007-19.

Misati, Roseline N., and Esman M. Nyamongo, "Financial Liberalization, Financial Fragility and Economic Growth in Sub-Saharan Africa," *Journal of Financial Stability*, 8 (September 2012), 150-60.

Van den Heuvel, Skander J., "The Welfare Cost of Bank Capital Requirements," *Journal of Monetary Economics*, 55 (March 2008), 298-320.